

AN OUTBREAK OF SYPHILIS IN AN INDIGENOUS TRIBE IN INDIA.

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NORMAN CHEVERS, in his *Commentary on Indian Diseases*, remarks that an outbreak of syphilis in a recently-affected tribe in India would be a very interesting study. Such an opportunity fell to my lot early this year (1901), the following account of which is based on shorthand notes of a large number of cases, made on the spot. The affected tribe was the Khonds, who inhabit the remote south-eastern corner of the tributary states of Orissa, between the north-east district of the Madras Presidency and the east of the Central Provinces : occupying a very sparsely-populated tract of dense jungle, which supplies all their primitive wants, and having very little dealing with surrounding districts, almost their only trade product being the roots of the turmeric plants. The particular group of villages which were affected was situated in a clearing of the forest, reached by a footpath, and their only dealings were with the town of Sonpur, some thirty miles distant, from whence the disease appears to have been introduced, some twenty or more years ago. Attention was recently attracted to the disease, owing to the late famine having necessitated the collection of a number of the people on a small relief work, when many of them were found to be suffering from ulcerations, and a native Civil Hospital assistant reported that the people were suffering to a large extent from syphilis, disseminated by flies and gnats; while the subdivisional officer stated that the disease had spread so rapidly among the children in an elementary school, that it had to be closed. This was all the information available before my visit.

On the afternoon of my arrival on the scene, after a journey of 120 miles from the railway, a few cases were collected from the nearest village, among which was a man with rupial sores all over the body; another with an extensive ulcer below one knee, and large nodes on the tibia

of the other leg; and a woman with ulceration and irregular thickening of the frontal bone; while in none of the rest were the lesions other than those commonly met with in syphilis. The alleged direct spread of the disease in the school remained to be cleared up; and on the following morning the children were collected, and it was found that only seven out of twenty-eight children had been attacked: two had died, two had recovered, and three were still ill. The latter presented the usual typical signs of congenital syphilis, while the two who had recovered showed evident marks of a recent attack of the same disease, their parents having also had syphilis. No direct infection could be traced among them, nor was there any evidence incriminating the much-abused mosquito. It remained to ascertain the extent of the prevalence of the disease, and any points of interest presented by it. In the course of three days, some fifty cases of the active disease were collected from the few small villages, of from three to thirty houses in this tract, in some of which as many as ten per cent. of the inhabitants still showed lesions of syphilis, although large numbers, amounting in one village to one-tenth of the population, had died during the previous year of the disease, doubtless aggravated greatly by mal-nutrition resulting from the famine conditions. A still larger number showed scars of previous outbreaks; while, as none of these poor people had used any treatment other than sulphate of copper solutions externally, and jungle roots internally, very many of them must retain the active virus in their systems; and it is no cause for wonder that the recent scarcity had caused numbers of them to break out in every loathsome manifestation of this protean affection, from numberless rupial sores to extensive ulcerations with necrosis of bones. Altogether, I doubt if much less than half the adult population were constitutionally affected.

Still worse was the state of the children: for, in addition to the large proportion with active lesions of the disease, on examining all the "healthy children" who could be collected, I found no less than 9 out of 17, or over one-half, showed evident marks of having been affected by the congenital form of the disease. Adding to these 13 cases of active congenital disease, the main symptoms were met with in the following proportions:—Out of the 22 cases, condylomata, or scars of them, were found in 21; ulcers at the angle of the mouth, or their scars, in 20; snuffles, or depressed bridge of the nose, in 19. In no case was interstitial keratitis seen, or a history of it obtained, although it

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was carefully looked for, and several of the children were old enough to have suffered from this symptom. Its absence may, perhaps, be due to the much lighter strain on the eyes of these children of the forest than on their brothers under the Board School *régime* in England. In one boy the permanent upper central incisors were stunted and slightly notched, and in another the upper right central incisor only was peglike and knotted; but these were the only cases with typically-affected permanent teeth, as described by Hutchinson. On the other hand, very marked deformity of the incisor first teeth were noted in five of the young children with congenital syphilis, although not seen in any of the healthy ones. It consisted in the affected teeth being both very stunted and also much narrower than normal, so as to leave a considerable space between both of them, while they were discoloured and roughened on the surface, but none of them showed any notch. In one child, aged five, the four upper incisors and the two central lower ones were affected; in two others, aged three and six, the four upper incisors only were deformed, while in one child of three the two lower central incisors only were involved. That five out of the twenty-two diseased children showed this deformity of the teeth strongly indicates that it was of syphilitic origin, especially as none of the unaffected children had any malformed incisor teeth.

Among the adults, one of the most notable features of the outbreak was the frequency of ulcers on the soles of the feet. This may have been due to their not wearing any covering to them, and so being very liable to slight injuries when traversing the rough forest tracts. These ulcers were often multiple, and assumed the form of deep cracks in the thick horny layer which is normal in these people; and they were often situated at the edge of the sole, and caused great difficulty in walking, and much distress. The men suffered most from this affection. Very extensive ulceration below the knees, with loss of bone, were also not uncommon, some of them having lasted several years. Among curious cases was a woman with an ulcer on the left nipple, somewhat resembling a primary sore, but clearly of a late secondary nature, as she had condylomata, rupial sores on other parts of the body, while her husband and her child of three years were also affected. Another boy, of about eight years of age, showed numerous condylomatous sores, two of which formed warty growths on the skin of his penis.

Some idea of the extent to which the disease had spread may be conveyed by the following record of a group of related families. A man, aged forty, presented a secondary rash and ulcerated throat, and a scar at the base of the glans penis. Yet he denied ever having had a primary sore: as indeed did all these forest men, differing in this respect from townspeople. His wife and child are said to be healthy, his infection being evidently recent. In the same village live three nephews of this man. The first is aged about thirty, and now has ulcers on the soles of his feet and round the knees. His wife has condylomata in the armpits, numerous rupial sores, and an ulcer on the left nipple. She has had two children, one of whom died with symptoms of congenital syphilis in childhood, and the other, aged three years, now shows ulcers at the angles of the mouth, snuffles, narrow, stunted, peg-like lower two central incisor teeth, and enlargement of the liver and spleen, with fever—although the latter may be malaria, which is very rife at this place. With this family another nephew, aged seven years, lives, and he has been ill two years, commencing with a rash all over the body. He now shows condylomata and rupial sores, and snuffles. The third nephew lives in a separate house. He is aged about 30, and has been ill about three years, and now shows numerous rupial sores. His wife shows ulcers on her feet, and numerous scars of old ulcers on different parts of the body. She has had two children, one of whom died when one year old, and the other when three, both with symptoms of congenital syphilis. In the same village are seven other households, not related closely to the above families, and they are all said to be free from the disease. The above-described group affords a terrible picture of the ravages of untreated syphilis among an ignorant people.

The details already given are sufficient to indicate the terrible extent of the disease among these people; but it is also of interest to determine how long syphilis had been present among them, and whence it came. The histories of different cases clearly showed that the disease had been present somewhere about twenty years. One man gave a history of rash and sore throat, followed by rupial sores, beginning twenty-five years ago; and he now had a very large ulcer just below the knee, of three years' duration. The calculations of these people, however, cannot be implicitly relied on. Of more importance is the evidence derived from the following two interesting cases of late

manifestations of the congenital disease in a brother and sister, aged twelve and eighteen years respectively. Both their father and mother suffered from syphilis before they were born, according to the mother herself, who presents numerous scars of old ulcers round the knees, on the feet, and other parts. Five other children died young, particulars of which could not be obtained. The daughter suffered from ulcers at the corners of the mouth, and snuffles when an infant, and broke out in ulcers leaving scars when five years old. Two years ago, large ulcers broke out round the right knee, which lasted one year, and the resulting scars have caused some deformity of her right foot by their contraction. The boy, now aged twelve years, suffered from rash, ulcers round the mouth, and snuffles when a child. Last year, several large holes appeared on the bones of both legs, and a small one on the right ulna, which still persist, and present a very characteristic appearance. Neither of them show any affection of the teeth. These cases were clearly of congenital origin, and their parents must have suffered from syphilis about twenty years ago. It is not quite so certain whether the disease may not have been present much more than twenty years, but several of the old men were positive that it was unknown within their memory, and that it had been introduced from Sonpur somewhere about twenty years back, when trade with that place began to bring them into contact with the Sonpur people; and this statement is borne out by the fact that syphilis has been very prevalent in the town of Sonpur for many years past. The evidence, then, points to the disease having been introduced to this group of villages about two decades ago, during which time the majority of the people have become infected by either the constitutional or congenital disease, partly owing to their low standard of morality, and direct infection from crowding and uncleanness; and no specific treatment ever having been adopted, the recent famine conditions so lowered their vitality as to allow the virus to manifest itself actively in a number of them, with a resulting high mortality and the production of the terrible series of cases which I saw. A dispensary is now being started for their treatment; while, fortunately, the infected community is a small and very isolated one.

FILARIASIS IN THE WEST INDIES AND ITS PREVENTION.

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THE life-history of *Filaria nocturna*, the nematode worm that is responsible for the large group of diseases classified under the term "Filariasis," has now been completely worked out, and the gradual steps that have led up to this knowledge have now passed into the realm of ancient history: a history, however, which is so interesting that we may briefly refer to it here in the preliminary part of this lecture.

BIBLIOGRAPHY.

As long ago now as 1863, Demarquay, in Paris, first discovered the embryo of *Filaria nocturna*. One day, on microscopically examining some fluid removed by paracentesis from a lymphatic swelling of the scrotum in a young man from Havana, he was astonished to find several very minute cylindrical worms amidst the cellular structure and other *débris*, and he published this remarkable fact in the *Medical Gazette* of Paris* of the same year, giving a very fair illustration of the parasites as well.

Strangely enough, his discovery attracted no attention, and in the course of a few years it appears to have been totally forgotten and lost sight of.

Wucherer, in Bahia, in ignorance of this paper, re-discovered the embryos, however, in cases of chyluria in 1866; and after collecting a series of twenty-seven such cases, in all of which he found similar parasites, published the results in the *Gazzeta Medica de Bahia* in 1865 and 1869.†

No further advance of any great importance was made in the subject till Lewis,‡ in India, in 1872, found similar

* *Gazette Médicale de Paris*, 1863, chap. xviii, pp. 9, 665.

† *Gazzeta Medica de Bahia*, Dec. 5th, 1868, and Sept. 30th, 1869; und *Lenckart's Parasiten*, Band II, pp. 9, 646.

‡ Eighth, Tenth, and Fourteenth Annual Reports of San. Com. with Government of India.

embryos in the blood of a patient suffering from diarrhoea, and emaciation; these he named, on account of their peculiar situation, the *Filaria sanguinis hominis*, a nomenclature which was adopted and retained till quite recently, when Manson, on discovering that this was only one of many worms that inhabit the blood of man, changed it to *Filaria nocturna*.

After Lewis's investigations everyone working at the subject agreed that these small, actively-moving worms seen in the blood must be the young or embryonic forms of adults, lying somewhere or other in the body of the host, and observers began systematically to search for them.

The honour of discovery eventually fell to Bancroft, in Brisbane, Queensland,* as, while opening a lymphatic abscess in the arm of a patient one day, in whose blood filarial embryos had been demonstrated, he found a small worm, 3 inches to 4 inches long, and about the thickness of a human hair. Soon afterwards he obtained more from another case, sending them to Cobbold, in England, for identification;† and the latter authority, on examining them, found embryos in the uterus of one in shape and measurement exactly similar to specimens seen in the blood of other cases, and so came to the conclusion that the young forms found swimming free in the blood of people suffering from filarial disease were the offspring of parent worms living in the lymphatic trunks of man.

In 1878 your President, Dr. Manson,‡ in Amoy, China, made the very remarkable and far-reaching discovery that certain species of mosquitos act as the intermediate hosts for the further development or metamorphosis of the embryonic *filariae*. Being struck by the fact that the embryos in the blood showed no evidence of growing or in any way changing, he was led to the belief that in some way or other they must enter an intermediate host to allow of their further development: a mode of procedure so common amongst the various forms of parasitic worms.

Starting on this assumption, he began to examine different suctorial insects which were known to have fed on infected cases, and amongst these mosquitos formed the large majority, as they were very prevalent in the district. In all of those examined he found that the *filariae* were

* *Lancet*, July 14th, 1877, and Cobbold, *Parasites*, 1879.

† *Lancet*, October, 7th, 1877.

‡ *Lancet*, May 12th, 1878; *Proc. Linn. Soc.*, March 7th, 1878; *Medical Times and Gazette*, London, 1878; *Transactions*, Linn. Soc. of London, 2nd Series; *Zoology*, vol. ii, Part x, p. 367.

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ingested with the blood into the stomach, but that in most of them they were slowly digested and disappeared; the exception to this rule being the case of a small brown unstriped mosquito, nocturnal in its habits.

In the case of this insect the embryos, instead of dying and gradually disappearing, bored their way into the tissues of the host, chiefly the thoracic muscles, and there underwent a most remarkable development. To follow these changes out accurately, a Chinaman, who had filarial embryos in his blood, was persuaded to sleep in a specially-erected wooden framework, covered with mosquito netting, the door of which was left open for a short time each night to allow of mosquitos entering to bite; and then in the mornings the gorged insects seen hanging on to the netting were carefully caught and put in stoppered bottles, being kept there till required for dissection. Three species of mosquito were in the habit of visiting the house: two of the variety known as the "tiger," sooty in colour, with white bands on their legs, while the third was a small brown mosquito called the *Culex pipiens*, but which our present knowledge of tropical mosquitos would now clearly indicate to be *Culex fatigans*, the common domestic or house-mosquito of the tropics. The former two proved to be inefficient, but in the latter the embryos migrated to the thoracic muscles and there underwent a metamorphosis, attaining in about eight days an enormous size, $\frac{1}{16}$ th of an inch in length by $\frac{1}{80}$ th of an inch in breadth, and, further, now possessing a well-developed alimentary canal and other structures. As most of the insects died, about this time, Dr. Manson put forward the view that in Nature the mosquito, after laying its eggs on water, died there and disintegrated, thus freeing the young embryos, which could presumably live in this medium until taken up by man, when they would by passing through the stomach gain some lymphatic trunk, and there become the mature parasite again.

Confirmation of this wonderful metamorphosis soon appeared. Lewis,* in India, on beginning a systematic research into the subject, was astonished to find that, when care was taken, 14 per cent. of the mosquitos taken at random around his house contained filarial embryos. He followed out the different changes undergone in the muscles of the insects, but did not describe forms later than the fourth or fifth day, most of his mosquitos then dying.

* *Proc. Asiatic Soc., Bengal*, March, 1877, pp. 9, 89; and *Fourteenth Annual Report of the San. Com. with Government of India*, 1878.

Insino,* in Egypt, in 1882, also did similar work, but failed to find such advanced forms as the former two observers.

For many years matters remained in *statu quo*, till Grassi,† in Italy, in 1890, indirectly confirmed the insect phase of the filaria of man, by demonstrating that the embryos of *Filaria recondita*, a blood-worm of dogs, undergoes a similar metamorphosis in fleas. Briefly stated, the parental forms live in the fatty tissues round the hilum of the dog's kidneys, their embryos passing from there into the blood; and then, when fleas, especially *Pulex serraticeps*, feed on such infected animals, they ingest the parasites into their stomachs.

From there, the embryos pass through the stomach, embed themselves in the fat-cells, and undergo four stages of development, eventually becoming almost mature. Infection experiments by feeding dogs with such fleas gave negative results.

In 1899, Bancroft (junr.),‡ in Australia, worked out afresh the metamorphosis of *Filaria nocturna* in the mosquito, and verified completely the previous discoveries, at the same time amplifying them, and suggesting other important details.

Before commencing his work, he made a special study of the habits of mosquitos, and found that to keep such insects alive for any length of time, it was necessary to feed them on suitable juices or fruits.

He began his series of experiments by first rearing large numbers of young mosquitos from eggs taken from water; and, when those became insects, they were fed on a girl with *filariæ* in her blood. Serial dissections of such insects, day by day, showed that the final metamorphosis in Australia was reached by the sixteenth or seventeenth day; most of the mosquitos easily living for this period of time when fed on bananas and similar fruits.

Of more importance, however, than these results, were his experiments on dissecting mosquitos with metamorphosed embryos in them in water, so as to allow the contained parasites to escape into that medium. He found that they only lived for three to four hours, and so came to the conclusion that water was injurious to them, and not the medium by which they are transmitted to man, the

* *Medical Times and Gazette*, May 27th, 1882, p. 554.

† *Centralbl. für Bakter. und Parasiten*, Band II, No. I, 1890; also John Hopkins, *Hospital Reports*, vol. viii, 1892 (Nuttall).

‡ *Journal of Tropical Medicine*, London, November 15th, 1899, p. 91.

final host. On those grounds, he brought forward two theories: firstly, the accidental swallowing of mosquitos, which seemed highly improbable; and, secondly, a suggestion that the *filariae* might come out by piercing the oesophagus of the mosquito when it was sucking blood, and so get into the system of man through the skin. About the same time, Bancroft made a large collection of filariated mosquitos, preserved them in glycerine, and sent them home to Dr. Manson in London.

While working in the London School of Tropical Medicine, on this material, in the spring of 1900, I was able to demonstrate the path* by which the young *filariae* escape from their intermediate host, the mosquito; namely, through the proboscis of the insect, thus disproving the water-transmission theory, and making filariasis a directly inoculable disease. These conclusions were reached by making serial sections of mosquitos with a microtome after embedding the insects in celloidin. By this means, it was found that the young *filariae* after reaching their highest stage of development in the insect, instead of lying passively in the thoracic muscles, leave that tissue, and travel forward in the direction of the head of the mosquito, passing into the loose cellular tissue which abounds in the prothorax, in the neighbourhood of the salivary glands. After a short stay there they pass into the head, remain for some time below the cephalic ganglion, and then pass into the proboscis, where they lie awaiting an opportunity of gaining access again to man, when the mosquito re-bites.

Working, simultaneously, in India, Captain James,† of the I. M. S., while dissecting fresh mosquitos, also found a completely metamorphosed *filaria* in the proboscis of one of those insects.

The proboscis view was, later in the same year, corroborated by Grassi,‡ in Italy, who, along with Noe, traced the embryo of *F. immitis*, one of the blood-worms of the dog, through the common *Anopheles maculipennis*. He found that the embryos developed in the Malpighian tubes and not in the thoracic muscles, and in about ten days became completely metamorphosed, migrating to the head of the insect, and so into the proboscis. By direct infective experiments on healthy dogs, he found that the worms passed from the proboscis into the tissues of the dog, and dis-

* *British Medical Journal*, June 16th, 1900.

† *Ibid.*, September 1st, 1900, p. 533.

‡ *Ibid.*, November 3rd, 1900.

appeared. His views on the exact position of the parasites in the proboscis, and how they escape, differ slightly from mine; but they in no way interfere with the main issue, namely, the fact that the worms pass directly into the human host.

GENERAL GEOGRAPHICAL DISTRIBUTION.

The geographical distribution of *Filaria nocturna* is tropical, and, to a lesser degree, sub-tropical. Its greatest prevalence is between the latitudes of 30 deg. north and 30 deg. south; that is, roughly speaking, in those regions with a higher mean temperature than 70 deg. Fahr., though it is also found in the sub-tropics, where the temperature falls short of this mean. The probability is, however, that in such places as Charleston in North America, Carthagera in Spain, Brisbane in Australia, it has been introduced by the sea from the tropics, and, finding a sufficiently high temperature at part of the year for its development in the mosquito, has remained and become indigenous. It has been found and reported on in many of the tropical regions in Asia, Africa, North and South America, Australia, and also in many of the islands. In the New World, it has a wide range, from Charleston in the north to the Brazils in the south: this including the West India Islands, from Cuba to Trinidad, the part of the world which specially concerns us.

THE LIFE-HISTORY OF *FILARIA NOCTURNA*.

Intracorporeal Phase.—The life-history of the parental forms of *F. nocturna*, and of its embryos which inhabit the blood-stream, is so fully described now in the text-books on tropical pathology,* that we need only glance at it here in passing.

The parent *filariæ*, long hair-like transparent nematodes, 3 in. to 4 in. in length, live in some part or other of the lymphatic system of man: sometimes in the thoracic duct, sometimes the pelvic lymphatics; or, again, in the distal lymphatics of the limbs. The female is larger than the male, measuring 3 in. to 4 in. in length; i.e., 76 mm. to 100 mm. by $\frac{1}{10}$ th to $\frac{1}{12}$ th of an inch, .288 mm. to .211 mm. in breadth, and they are visible to the naked eye, resembling fine catgut or a piece of white thread. In both cases

* Manson, *Trop. Diseases*, second edition, 1900.

the head is club-shaped, with a simple circular mouth, and is joined to the body by a somewhat narrow neck. The body-cavity, enclosed by a longitudinal layer of muscular fibres, contains a well-developed alimentary canal, and the generative organs, which are well developed in both sexes. The uterus of the female becomes filled with ovoid-shaped eggs, out of which a small embryo appears; and these, after being born alive into the lymph-stream, find their way *viâ* the thoracic duct into the general blood-circulation. It has not yet been determined how long the adults are capable of living, but it is to their presence that the various pathological lesions found in filariasis are attributed. Their death and decomposition often act as the nidus for abscess-formation; and, by augmenting inflammatory changes in the lymphatic vessels, cause the well-known filarial lymphangitis, or even the more terrible disease, elephantiasis.

The embryonic forms in the blood may easily be demonstrated by taking a drop of blood from an infected person at night, and examining it under the low power of the microscope. It will then be seen that they are minute little creatures, like miniature snakes or eels, and can be watched wriggling about amongst the red blood corpuscles. With a high power they appear cylindrical, with a rounded head and a tapering tail; have a mouth and a central column of cells, are enclosed in a fine sheath; but, apart from those features, very little more can be made out. By day they disappear from the peripheral blood collecting in the blood-vessels of the lungs; but as night comes on they reappear, thus forming what Manson has termed "filarial periodicity."

Extracorporeal Phase.—Naturally, every blood-sucking insect that imbibes the blood of a filarial patient at night must necessarily swallow large numbers of embryos; but the large majority of such insects do not act as efficient hosts; *i.e.*, they are incapable of allowing of the development of the *filariæ* in their tissues; as the blood is digested so are the parasites, and they entirely disappear. A second class are what may be termed partially efficient: in their case the embryos not only migrate from the blood contained in the stomach to the thoracic muscles, but even undergo a slight development, which is, however, slow, and ends in nothing, death and absorption eventually taking place. Some species of mosquitos act in such a manner. The next, or third, class, are the completely efficient host, as in them the complete metamorphosis of the *filariæ* takes place, and

eventually they are capable of re-infecting man. Several genera of mosquitos, as far as our knowledge at present goes, come under this category.

Manson* found a small brown mosquito in Amoy, called the *Culex pipiens*, but which probably was *Culex fatigans* efficient; while Bancroft, junr.,* in Australia, found *C. ciliaris*, the common house-mosquito of those parts, to be the same. James, in Travancore,* found *Anopheles Rossii*; the second expedition of the Liverpool School of Tropical Medicine to the West Coast of Africa found *Anopheles costalis*;† Daniels,‡ in Central Africa, found *Panoplitus Africanus* (Theobald); and working in the West Indies I have found *Culex fatigans*§ and *Anopheles albipes* (Theobald). It is quite possible as time goes on more may be incriminated, but even without such being discovered it is seen that quite a large number can act as efficient hosts for disseminating the disease.

Though almost completely mature forms can be detected in the thoracic muscles of *Anopheles albipes*, a common West Indian mosquito, nevertheless the chief carrier of the infection, as far as the West Indian islands are concerned, is *Culex fatigans*, which along with *Stegomyia fasciata*, forms the common domestic or house-mosquito of those parts. This being the case, we may trace the metamorphosis of the embryo *filaria* through *Culex fatigans*; as, though the time noted by me as taken in St. Lucia varies somewhat from that described by other observers in different parts of the world, yet the changes undergone may be taken as typical of the whole class.*

Starting with mosquitos reared from larvæ, so as to make sure of an uninfected stock, the mature insects were allowed to feed at night on a negro with numerous filarial embryos in his blood, and were then kept in houses, with bananas for food, till required for dissection.

Twelve to twenty hours after feeding, large numbers were seen to have arrived in the muscles, and even in forty hours showed a considerable amount of change, there being an increase in the number of cells, and a fine cuticle tapering to a point posteriorly. By the end of four and a half days the sausage stage is reached, the alimentary canal has begun to form, and the mouth and

* Loc. cit.

† *British Medical Journal*, "Malarial Expedition to Nigeria," Jan., 12th, 1901, p. 97, and *British Medical Journal*, Sept. 7th, 1901, p. 612.

‡ *Jour. Trop. Medicine*, London, June 15th, 1901, p. 193.

§ *British Medical Journal*, June 1st, 1901, p. 1336.

anus are visible. From this time growth goes on with great rapidity, and at six and a half days the embryos have lengthened still further, showing now a mouth, an anus, and an alimentary canal quite distinct and well formed. On the following day the œsophageal bulb appears, most have lost the fine cuticle, and some show the commencement of the trilobed tail.

At eight and a half days they measure 0.88 mm. in length by 0.04 mm. in breadth, the large cells which originally formed the intestinal tube having at this date become transformed into five small cells, and the whole appearance very much resembles that seen in the final stage of development.

At ten and a half days, forms measuring 1.26 mm. ($\frac{1}{20}$ th in.), to 1.3 mm. in length by 0.04 mm. in breadth, are seen. Anatomically they present a mouth, an œsophagus, an œsophageal bulb, and a long alimentary canal ending at the anus, which is situated some little distance above the trilobed tail. Movement is now very active; though they do not change their positions on the slide, they are constantly twisting and coiling themselves about in what has been called a purposeless manner, very much resembling the movements of the immature embryos when seen in a drop of blood.

By the following day, eleven and a half days metamorphosis is complete, and mature forms are seen in the head and neck, and proboscis, and more rarely in the abdominal cavity. The embryos vary somewhat in length, and the muscles may show a number of short *filariæ* that have developed more slowly. The largest now measure $\frac{1}{16}$ th of an inch in length, 1.60 mm. by .024 mm., .032 mm. in breadth; the mouth is still simple. An œsophagus, expanding into a bulb, opens into the intestine, which was seen previously to end in an anus some distance above the trilobed tail. A musculo-cutaneous layer is seen under the cuticle, and there is some differentiation of cells to form the generative organs, not sufficiently developed, however, to tell the sexes from each other.

When the mosquito next bites man, any *filariæ* situated in the proboscis pass from this site under the skin of the person punctured, and then make their way to some lymphatic trunk, where they increase still further in length, become sexually differentiated, and so re-start their complicated cycle of life.

PREVALENCE OF THE DISEASE IN THE WEST INDIES.

In estimating the prevalence of filarial disease in any given area, it must be remembered that the majority of persons affected show no clinical symptoms whatsoever; and although one may get a rough estimate by noticing the number of cases of elephantiasis and other filarial complaints in hospitals and poor-houses, the only way of accurately determining the approximate amount of infection is to examine the blood of as many of the population as possible at nights for filarial embryos. This, though a tiresome task in many instances, is easy, and the blood of a hundred individuals or more may be taken each evening between 9 P.M. and midnight, the subsequent examination being left over till next morning.

The results of the statistics collected from British Guiana and some of the West Indian islands show that, as a whole, those places have a smaller percentage of the disease than many other parts of the tropics, especially than some of the Oceanic islands in the South Pacific.

When one, however, considers the islands, and British Guiana on the mainland, separately, it is at once seen that each individual place varies very greatly, one island, even from the next closely adjoining it, the more or less flat and cultivated ones having a much larger amount of the disease than those which are hilly and mountainous.

Of all the places specially examined, St. Kitts, one of the leeward group of the lesser Antilles, easily stands first, no fewer than 32.8 per cent. of the inhabitants suffering from filariasis.

The island is of volcanic formation, consisting of a central core or ridge of mountains, with the land sloping gently from this to the sea, this being sandy and porous in nature, and extensively cultivated with sugar cane.

Even in the wet season, with the exception of some swamps or low-lying ground on the windward side of the island, very little water stands in the country districts, large watercourses carrying it quickly away to the sea.

The town of Basseterre, situated on flat sandy ground on the seashore near the end of the central ridge, is typically West Indian, native huts and dwellings being intimately mixed up with the houses of the better-class white population, and in this area *Culex fatigans*, the common domestic mosquito of those parts, is very prevalent, breeding chiefly in the privies with which the town is abundantly supplied, and also in other collections of water so common in West

Indian towns and villages, and which we will deal with later under the prevention of the disease.

Dominica and St. Lucia, the two most mountainous islands of the group, suffer comparatively slightly, only having 7.63 per cent. and 7.58 per cent. respectively, and the clinical manifestations correspond, few cases being treated annually in the hospitals, and few individuals suffering from elephantiasis being seen about the streets and other places. Their chief towns (Roseau in Dominica, and Castries in St. Lucia) are situated on the leeward coasts in hollows, shut in all round by high mountains, and are very hot with little breeze, and many native dwellings are found all over the centre and outskirts.

Stegomyia fasciata, one of the domestic mosquitos of those parts, an inefficient host for the filarial parasite,* is commoner than *Culex fatigans*, and this may account for a corresponding diminution of the disease.

Barbados, the most easterly of the Caribbean Islands, consists of a flat coral formation, only attaining to about 1000 ft. above sea-level at its highest point. For its size, 21 miles long by 11 miles broad, it is very densely populated, containing no fewer than 200,000 inhabitants, about 30,000 of whom live in Bridgetown, the chief town of the island. It is peculiar in having no proper rivers, very little standing water of any kind, and *Anopheles* mosquitos and malarial fevers are non-existent;† on the other hand, however, filarial disease is very common, 12.66 per cent. of the people suffering from it. With its dense population, chiefly negroes, and their persistent habit of storing water in barrels and other similar receptacles, which afford suitable places for *C. fatigans* breeding in, this is not surprising. Before the water supply was brought into the town there is no doubt that the disease was much more prevalent than it now is, and elephantiasis was then so common as to give rise to the local name of "Barbados leg" for this complaint.

The next island, St. Vincent, mountainous and hilly, with a sparse population, has only 6 per cent. of its inhabitants infected; and Grenada, to the south of this, enjoys the enviable distinction of only having .56 per cent. of the disease; the clinical manifestations again bearing this out, as cases of filariasis are practically never got in the hospitals, and the medical men throughout the island have

* *Loc. cit.*

† *British Medical Journal*, Sept. 4th, 1901, and *Jour. of Trop. Med.*, London, Sept. 2nd, 1901.

very rarely seen it. Why this should be is rather difficult to appreciate, and is very interesting. The island, it is true, is mountainous, and St. George's, the chief town, is largely built on the slopes of the hill-sides overlooking the harbour; but even then there are plenty of native huts where water is often kept standing for long periods of time, and *C. fatigans*, though not perhaps numerous, still exists. Here we have, then, a tropical island, with a suitable intermediate host present, and sources of infection coming in by the immigration of Barbadians and others, and yet the disease never seems to have taken root and spread. That it can live in the island is proved by cases of elephantiasis occurring in people who have never been out of the island.

Trinidad, to the south of Grenada, close to the mainland, gives a percentage of 10.75 per cent.; that is somewhat less than Barbados. Port-of-Spain, its chief town, has a very mixed population, and has plenty of native huts in its immediate vicinity. It is a fine town, well built and well drained; but, even with this, *C. fatigans* is common, and tanks and other breeding-places are far from rare.

Leaving the islands now, and passing to British Guiana, situated on the mainland of South America, some very interesting features are to be made out in connection with the disease. *F. nocturna*, which is much more abundant (viz., 22 per cent.) than in the other islands, with the exception of St. Kitts, is only got in the towns and coast-line, and not in the primæval forests which clothe the interior. East Indian immigrants also, who live chiefly in the country on the sugar estates, enjoy a much greater immunity than the Negroes, Creoles, Portuguese, and others who live in the towns, where the percentage given above was calculated.

Georgetown, the chief centre of the colony, of course affords splendid breeding-grounds for all sorts of mosquitos, trenches or canals existing in many of the main streets; and further, as the water-supply is bad, the lower classes have to store rain-water in barrels and other situations for their drinking supply. This being the case, the breeding-grounds for the intermediate host, *C. fatigans*, are simply legion; and those operating on a dense population, quickly spread the disease: the wonder being that more does not exist with circumstances so favourable for its spread.

All types of the disease are met with in the West Indies, the most infected places showing more of the rarer manifestations.

Filarial lymphangitis, locally termed in Barbados "fever and ague," the "elephantoid fever" of Fayrer, is very common in Barbados and St. Kitts, and very few of the white people, who have been born or lived most of their lives in those islands, have escaped attacks at one period or other of their existence. Lymph scrotum, vaccine groin glands, and abscesses due to the *filariae*, are all common throughout the West Indies, as is also the case with elephantiasis. Affections of the lower limbs are the most frequent site of this unsightly complaint; but, in the intensely filarial places, Demerara and St. Kitts, it is often seen in the scrotum, penis, prepuce, breasts, ears, and also in the form described as the pedunculated groin elephantiasis by Daniels* in Demerara and Corney† in Fiji.

THE PREVENTION OF FILARIASIS IN THE WEST INDIES.

The prevention of this disease, as far as some of the West Indian islands are concerned, is simple, not only theoretically but practically. The dangerous class of case to the community at large is very often not the one that exhibits pathological symptoms, as in almost all cases of elephantiasis, and in many cases of filarial lymphangitis, the embryos disappear from the peripheral blood; but the one that exhibits no definite symptoms at all, though having his blood infected with parasites. It is clear, therefore, then, that everyone with filarial embryos circulating in his blood may spread the disease to other people in the same house and vicinity—not directly, but by infecting the special species of mosquitos which are efficient to allow of the development taking place in them. These infected mosquitos live and frequent the house, biting fresh people every three days or so; and, eventually, when the parasites have arrived at maturity, and are situated in the proboscis, re-inoculate the original person again, or inoculate fresh individuals.

As a means of personal prophylaxis, then, every one in a tropical climate should always sleep under a properly-applied mosquito net. If he should happen to harbour embryos in his blood, then he will not infect mosquitos; and conversely if he is free, he will not be bitten, and so inoculated by infected mosquitos. It is an astounding fact, that though Dr. Manson's original discovery of the part played by mosquitos in the spread of this disease dates back to 1878, that very few of the people permanently

* *British Guiana Medical Annual*, 1896.

† *Lancet*, April 6th, 1889.

residing in the West Indies ever use mosquito netting. In a long series of cases of the disease in the better-class white population in Barbados and St. Kitts, the usual answer to the question of "Do you sleep under a mosquito net?" is "Oh, no, mosquitos never bite me; and besides, they are hot and stuffy." The proof of the fact that mosquitos do bite them is, that they are infected; and the question of the heat is only a loophole for escape.

It is really a matter of carelessness and lethargy, which is so apt to appear in people permanently residing in those tropical parts; and this is aided by the fact, that though they are nightly bitten by mosquitos, very little irritation or mark is left on their skins, a gradual immunity to the effects of the bites being obtained by prolonged residence in the climate. It follows that a much more careful use of this easy means of personal prophylaxis for the wealthier classes would help to diminish the disease, and would prevent much of the useless suffering that is at present undergone by them.

This method of prevention is, of course, only palliative, and is useless for the bulk of the native population, who would never adopt it; so the real *crux* of the question turns on the destruction of the intermediate host, the mosquito, without which the disease could not go on.

Culex fatigans and *Anopheles albipes*, I have shown you, are the two disseminators of filariasis in the West Indies; and, as the latter is, firstly, non-existent in Barbados, and, secondly, is non-existent in most of the towns of the different islands—with the exception of Georgetown in Demerara—places where most of the filarial infection is found, and the disease commonest, the whole matter therefore turns on the abolition of the former. To get rid of this pest about houses is comparatively easy, if the action is universal, and if their life-history is studied to see which is the most vulnerable point to strike them at.

As the habits and breeding-grounds of *Stegomyia fasciata*, an inefficient host for *F. nocturna*, but the host for yellow fever, are identical with the one we are considering, and, as they co-exist in all of the islands, the means adopted for the destruction of the one will equally apply to the other.

Culex fatigans, the common domestic mosquito of the West Indies, then, is a small, brownish-yellow insect, the males being harmless; *i.e.*, not biting, and being distinguished by their more slender build and feathery antennae.

It is essentially a domestic mosquito, not being found far

from houses, and is nocturnal in its habits; sleeping by day in the darkest part of the room it can find, and only becoming active just as darkness begins to appear. Its presence when near one can be readily detected by its humming or piping noise; and then, choosing an exposed part, it gently settles, and proceeds to bite, remaining if not disturbed for a considerable time, sucking up the blood. After its meal, it is gorged and heavy, and rising slowly, seeks some quiet spot where it may sleep off the effects of its meal; remaining here more or less torpid for a day or two, till all the blood is digested, and then it is ready to start afresh.

The eggs of this species are deposited in boat-shaped masses, in any artificial collections of water, such as tanks, water-barrels, wells, tubs, cisterns, and gutters.

In about two days each egg gives rise to a small larva, which swims about in the water, grows rapidly, and feeds on the animalculae and other organisms found there. They breathe by a long tube at the posterior end of the body, and have to come to the surface of the water to allow of the contact of the air, their position then being perpendicular, or at an angle with the head hanging downwards.

In twelve to fifteen days, according to the temperature, they change into the pupa or chrysalis; they now cease to feed, and the respiratory tubes become altered in position, now being found in the dorsum of the thorax. Two days are spent in this phase, and then the skin splits down the back, and the imago or perfectly-formed insect emerges, rests for a little on its cast-off case, and then flies away.

To diminish or to completely eradicate mosquitos, then, from a house, by striking at their larval stage, two ways are open to us: Firstly, either to have no collections of water for them to breed in; or, secondly, if such cannot be entirely done away with, to render it harmful to the insect, so that it can no longer develop in it.

In Barbados and St. Kitts, where there is now an abundant pipe water-supply, and plenty of stand-pipes exist at suitable places for people drawing water from when they require it, no standing water, such as water-barrels, wells, tanks, or other collections should be allowed at all; and this I have strongly represented in popular lectures to the Sanitary Inspectors and general population, and officially to the Governments of those islands. The expense would be trivial, and can be easily included in the estimates of the general sanitary work; and I am happy to

state that St. Kitts, with praiseworthy energy, has started at once in the matter, and Barbados is also following suit. For the other islands, where the water-supplies are not so good and not so generally applied, and for Demerara, which is almost totally dependent on a rain-water supply for drinking purposes, a certain amount of water must be stored, but there is no reason whatsoever that this should not be stored properly, and useless accumulations abolished.

I have proposed for Barbados and St. Kitts that a law should be passed authorising the sub-inspectors of sanitation, when they see barrels or tubs of water full of mosquito larvæ on their daily rounds, to have those emptied, and to impress on the individuals responsible the danger, and to see that it does not occur again.

The whole question is really one of sanitation; larvæ of mosquitos should be looked on as insanitary products, just in the same way as fæcal excrement, garbage and offal, and removed accordingly.

In towns where rain-water has to be collected for drinking purposes, as in Georgetown, Demerara, and on the Morne, at St. Lucia, where there is a military garrison, the water should be stored in iron tanks with perfectly tight-fitting roofs, and the doors for getting in to inspect and clean the tanks should also fit tightly, no apertures large enough for mosquitos entering existing. Water-barrels for a similar purpose could easily have mosquito-proof metallic netting applied over them; but then the poor population cannot probably afford this—or, what is more likely, are too careless and uneducated to think of such a thing.

It is a common habit amongst Barbadians to keep tubs of water in their gardens for growing water-lilies; and after one of my lectures an individual asked me if he could still keep those, as he had minnows in them, and never saw any larvæ swimming about.

I personally inspected his tubs, and found that he was correct in his statements; and, further, on procuring larvæ from another source, and introducing them beside the minnows, the latter immediately ate them up with great avidity. Other experiments conducted with gold fish gave similar results, so this affords us an easy and ready means for destroying mosquitos in certain varieties of water which it would be difficult or inconvenient to have absolutely done away with. Ornamental fountains, large tanks, tubs for growing water-plants in, ought therefore to have those small minnows or gold fish introduced, and they will then be mosquito-proof.

Privies, catch-pits, and old wells abound in all West Indian towns and villages, affording breeding grounds for many mosquitos; and those, in addition, being very insanitary, should be completely filled up, the earth system being adopted for number one, drains for number two, and nothing for number three, as they or any other substitutes are unnecessary.

Kerosene oil is useful in many cases, but is only temporary, costs money, and will, therefore, not become of universal use amongst the poor. Radical methods are much better for domestic collections of water than temporary ones, as they are almost as easy to carry out, and are permanent when accomplished.

By such a simple and inexpensive procedure, a house which was before infested with mosquitos can, in a very short time, be rendered almost entirely free.

It is by striking at the larval stage that we can hope for the best results; the destruction of the adults by fumigation and other means is much more troublesome and expensive, and is at the same time practically impossible, especially if a collection of water near at hand is constantly pouring in new generations of mosquitos.

The whole question of putting an end to disease by the destruction of mosquitos is new to the West Indies, and a considerable amount of opposition is met with in some of the more ignorant and superstitious of the islands.

Such arguments, however, proceed from more or less uneducated laymen who are ignorant of the scientific work done on the subject, and are really of no value, though in some instances they act prejudicially on the intensely stupid negroes.

As I have already said, St. Kitts and Barbados have taken up the subject, and there is no doubt that the other places will follow their example.

The Colonies ought now to know their danger and the means of combating it, and each Government must apply itself to the matter, spending a certain amount of money gradually in relation to the funds at their disposal, till they eventually free themselves from this loathsome and disgusting disease: one which is responsible for largely filling almshouses and other charitable institutions, and which brings much useless suffering to many of those unfortunately affected by it.

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